Large Area Photodector R&D

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Topics

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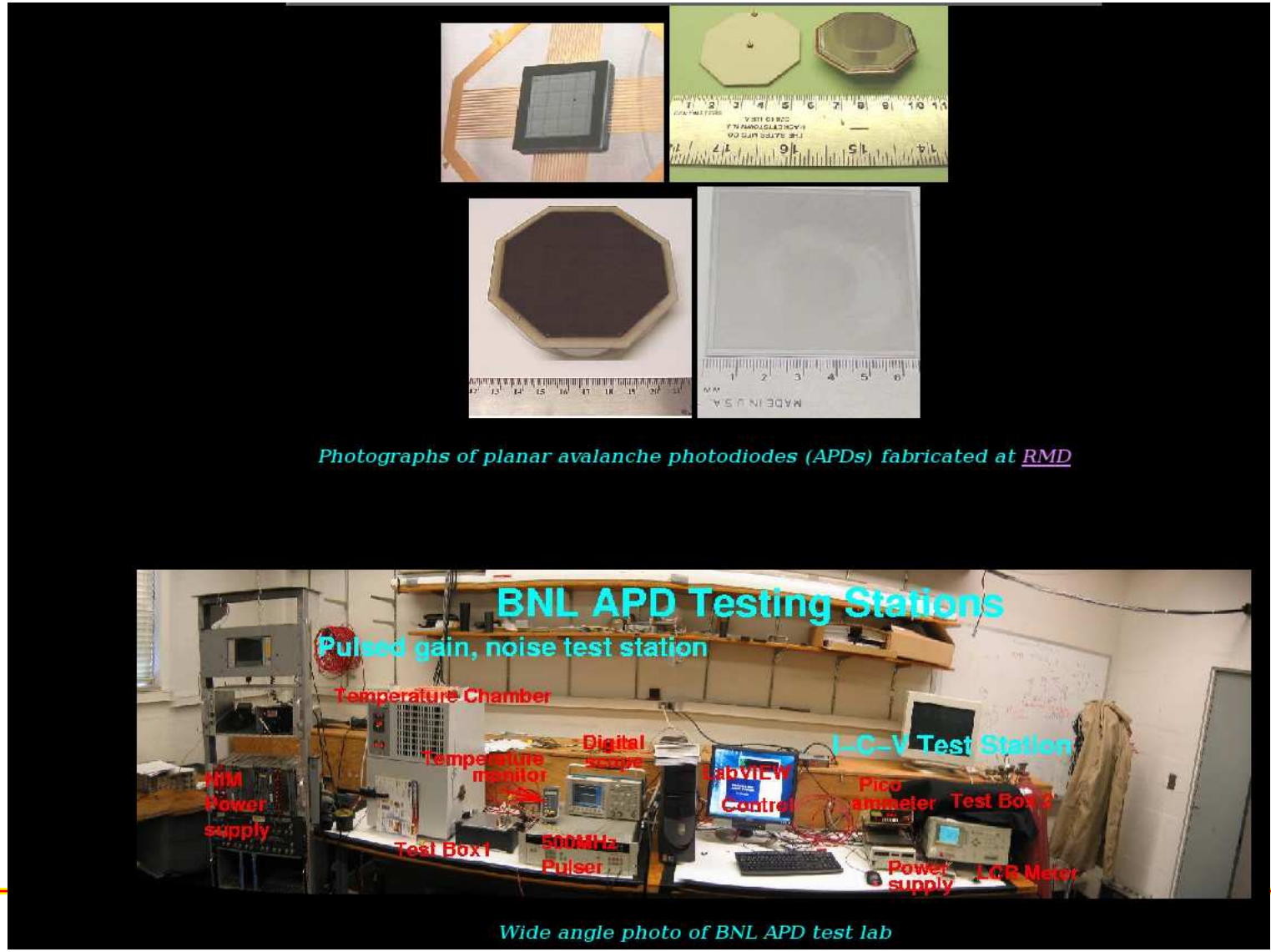
  - Large area Avalanche Photodiodes
  - Next generation large area photomultipliers
  - Operation of photodetectors in water
- Future directions
  - Hybrid photodetector technologies
  - Simulations of photodetector response
  - Water Cerenkov detector simulations

Program goals

Research into new photodetection technology with a particular emphasis on coverage of very large areas with direction sensitivity. The more specific goals are aimed at implementation of new and improved photodetection technologies to improve the lepton ID capabilities of kilo-ton scale Water Cerenkov detectors.

Large Area APDs

SBIR grant with Radiation Monitoring Devices Inc in Boston MA developed large area APDs (5x5cm, gain up to 10^3 - but too noisy):



PMT and WCe R&D

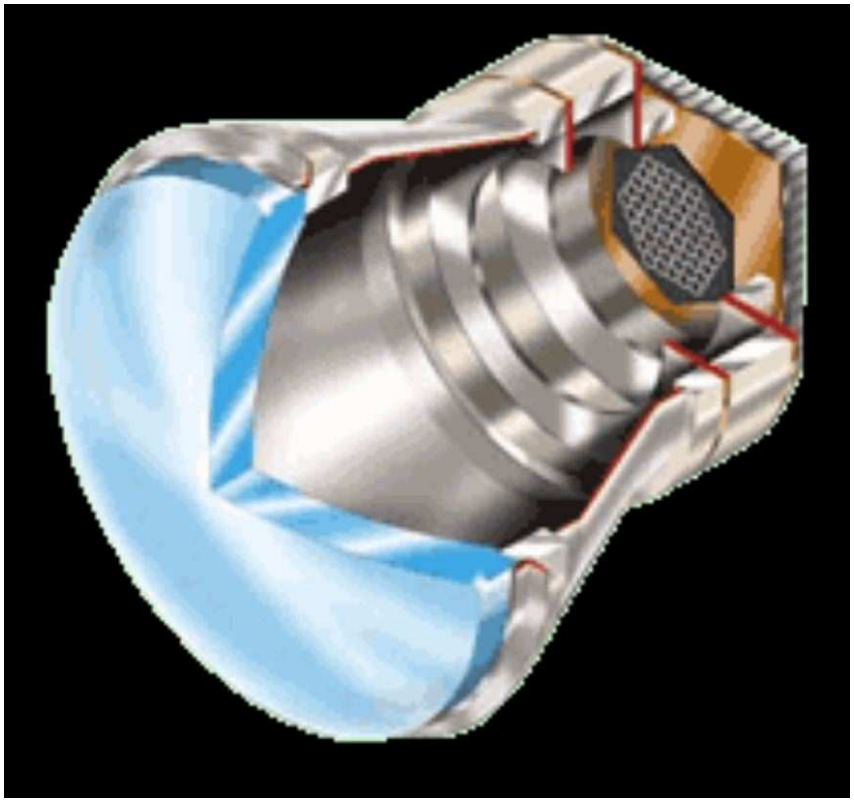
LDRD 06-004, “Detector Development for Very Long Baseline Neutrino Experiment”, Grant of $111k for FY2006.

- **Built and developed a pressure vessel for pressure testing of large PMTs in water - this work is for generic water Cerenkov detectors in collaboration with Orsay, France. Working with 2 photo-tube vendors to improve their designs.**
- **Developed a PMT test facility to characterize all operational aspects of next generation large area photodetectors - high QE, low noise, operation in magnetic fields...etc. This facility is used by both Daya Bay and Homestake-DUSEL R&D as well as by instrumentation division APD research.**
- **Built a water purification system for testing various purification techniques for water Cerenkov detectors. Currently used by Daya Bay and Homestake-DUSEL.**
- **Developed apparatus for measurement of light attenuation in various liquids. In collaboration with BNL chemistry and RPI (PhD thesis).**

Hybrid Photodetector R&D

Future directions:

P. Antonioli et al., The AQUA-RICH atmospheric neutrino experiment, Nucl. Inst. And Meth. A 433 104-120 (1999):



A simple lens or a mirror acts as an angle to position converter. Photons that are incident at the same angle anywhere in the lens aperture are focused to the same point on the focal surface. By measuring the position on the focal surface we can measure the incoming direction of the light. In a large particle physics detector photons are detected by photo-multiplier tubes. If these tubes were to be replaced by direction sensitive photo-sensors then we could obtain the direction of each detected photon. Knowledge of the location of the tube and the photon direction with good resolution will improve particle identification, energy resolution, and reconstruction of events with multiple particles

Water Cerenkov Particle ID

Future directions:

Simulation effort to develop novel Water Cerenkov detector particle identification techniques for high energy muons and electrons. We need to develop a simulation framework to assess the viability of a new photodetection technology in enhancing the lepton ID capabilities of water Cerenkov detectors.